THE BIOLOGY OF DEATH. III—THE CHANCES OF DEATH[1]

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1. The Life Table

Up to this point in our discussion of death and longevity we have, for the most part, dealt with general and qualitative matters, and have not made any particular examination as to the quantitative aspects of the problem of longevity. To this phase attention may now be directed. For one organism, and one organism only, do we know much about the quantitative aspects of longevity. I refer, of course, to man, and the abundant records which exist as to the duration of his life under various conditions and circumstances. In 1532 there began in London the first definitely known compilation of weekly "Bills of Mortality." Seven years later the official registration of baptisms, marriages and deaths was begun in France, and shortly after the opening of the seventeenth century similar registration was begun in Sweden. In 1662 was published the first edition of a remarkable book, a book which marks the beginning of the subject which we now know as "vital statistics." I refer to "Natural and Political Observations Mentioned in the Following Index, and made upon the Bills of Mortality" by Captain John Graunt, Citizen of London. From that day to this, in an ever widening portion of the inhabited globe we have had more or less continuous published records about the duration of life in man. The amount of such material which has accumulated is enormous. We are only at the beginning, however, of its proper mathematical and biological analysis. If biologists had been furnished with data of anything like the same quantity and quality for any other organism than man one feels sure that a vastly greater amount of attention would have been devoted to it than ever has been given to vital statistics, so-called, and there would have been as a result many fundamental advances in biological knowledge now lacking, because material of this sort so generally seems to the professional biologist to be something about which he is in no way concerned.

Let us examine some of the general facts about the normal duration of life in man. We may put the matter in this way: Suppose we started out at a given instant of time with a hundred thousand infants,

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equally distributed as to sex, and all born at the same instant of time. How many of these individuals would die in each succeeding year, and what would be the general picture of the changes in this cohort with the passage of time? The facts on this point for the Registration Area of the United States in 1910 are exhibited in Figure 1, which is based on Glover's United States Life Tables.

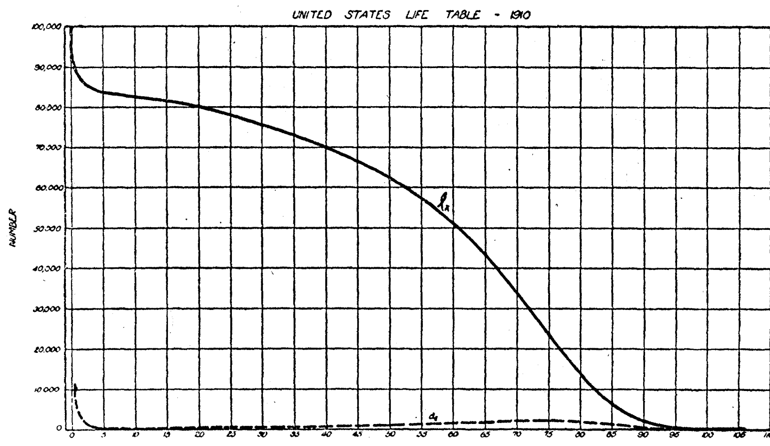

FIG. 1. LIFE TABLE DIAGRAM. FOR EXPLANATION SEE TEXT

In this table are seen two curved lines, one marked l_x and the other d_x. The l_x line indicates the number of individuals, out of the original 100,000 starting together at birth, who survived at the beginning of each year of the life span, indicated along the bottom of the diagram. The d_x line shows the number dying within each year of the life span. In other words, if we subtract the number dying within each year from the number surviving at the beginning of that year we shall get the series of figures plotted as the l_x line. We note that in the very first year of life the original hundred thousand lose over one-tenth of their number, there being only 88,538 surviving at the beginning of the second year of life. In the next year 2,446 drop out, and in the year following that 1,062. Then the line of survivors drops off more slowly between the period of youth and early adult life. At 40 years of age, almost exactly 30,000 of the original 100,000 have passed away, and from that point on the l_x line descends with ever increasing rapidity, until about age 80, when it once more begins to drop more slowly, and the last few survivors pass out gradually, a few each year until something over the century mark is reached, when the last of the 100,000 who started so blithely across the bridge of life together will have ended his journey.

This diagram is a graphic representation of that important type of document known as a life or mortality table. It puts the facts of mortality and longevity in their best form for comparative purposes. The

first such table actually to be computed in anything like the modern fashion was made by the astronomer, Dr. E. Halley, and was published in 1693. Since that time a great number of such tables have been calculated. Dawson fills a stout octavo volume with a collection of the more important of such tables computed for different countries and different groups of the population. Now they have become such a commonplace that elementary classes in vital statistics are required to compute them.

2. Changes in Expectation in Life

I wish to pass in graphic review some of these life tables in order to bring to your attention in vivid form a very important fact about the duration of human life. In order to bring out the point with which we are here concerned it will be necessary to make use of another function of the mortality table than either the l_x or d_x lines which you have seen. I wish to discuss expectation of life at each age. The expectation of life at any age is defined in actuarial science as the mean or average number of years of survival of persons alive at the stated age. It is got by dividing the total survivor-years of after life by the number surviving at the stated age.

In each of the series of diagrams which follow there is plotted the approximate value of the expectation of life for some group of people at some period in the more or less remote past, and for comparison the expectation of life either from Glover's table, for the population of the United States Registration Area in 1910—the expectation of life of our people now, in short—or equivalent figures for a modern English population.

Because of the considerable interest of the matter, and the fact that the data are not easily available to biologists, Table 1 is inserted giving the expectations of life from which the diagrams have been plotted.

TABLE I.

Changes in expectation of life from the seventeenth century to the present time.

Age	Average length of life remaining to each one alive at beginning of age interval.			Age	Average length of life remaining to each one alive at beginning of age interval.		
	Breslau, 17th century.	Carlisle, 18th century.	U. S. 1910		Breslau, 17th century.	Carlisle, 18th century.	U. S. 1910
0 - 1	33.50	38.72	51.49	50-51	16.81	21.11	20.98
1 - 2	38.10	44.67	57.11	51-52	16.36	20.39	20.28
2 - 3	39.78	47.55	57.72	52-53	15.92	19.68	19.58
3 - 4	40.75	49.81	57.44	53-54	15.48	18.97	18.89
4 - 5	41.25	50.76	56.89	54-55	14.99	18.27	18.21
5 - 6	41.55	51.24	56.21	55-56	14.51	17.58	17.55
6 - 7	41.62	51.16	55.47	56-57	14.02	16.89	16.90
7 - 8	41.16	50.79	54.69	57-58	13.54	16.21	16.26
8 - 9	40.95	50.24	53.87	58-59	13.06	15.55	15.64
9 -10	40.50	49.57	53.02	59-60	12.57	14.92	15.03
10-11	39.99	48.82	52.15	60-61	12.09	14.34	14.42
11-12	39.43	48.04	51.26	61-62	11.62	13.82	13.83
12-13	38.79	47.27	50.37	62-63	11.14	13.31	13.26
13-14	38.16	46.50	49.49	63-64	10.67	12.81	12.69
14-15	37.51	45.74	48.60	64-65	10.20	12.30	12.14
15-16	36.86	44.99	47.73	65-66	9.73	11.79	11.60
16-17	36.22	44.27	46.86	66-67	9.27	11.27	11.08
17-18	35.57	43.57	46.01	67-68	8.81	10.75	10.57
18-19	34.92	42.87	45.17	68-69	8.36	10.23	10.07
19-20	34.26	42.16	44.34	69-70	7.91	9.70	9.58
20-21	33.61	41.46	43.53	70-71	7.53	9.17	9.11
21-22	32.95	40.75	42.73	71-72	7.17	8.65	8.66
22-23	32.34	40.03	41.94	72-73	6.85	8.16	8.22
23-24	31.67	39.31	41.16	73-74	6.56	7.72	7.79
24-25	31.00	38.58	40.38	74-75	6.25	7.33	7.38
25-26	30.38	37.86	39.60	75-76	5.99	7.00	6.99
26-27	29.76	37.13	38.81	76-77	5.79	6.69	6.61
27-28	29.14	36.40	38.03	77-78	5.71	6.40	6.25
28-29	28.51	35.68	37.25	78-79	5.66	6.11	5.90
29-30	27.93	34.99	36.48	79-80	5.67	5.80	5.56
30-31	27.35	34.34	35.70	80-81	5.74	5.51	5.25
31-32	26.76	33.68	34.93	81-82	5.86	5.20	4.96
32-33	26.18	33.02	34.17	82-83	6.02	4.93	4.70
33-34	25.59	32.36	33.41	83-84	5.85	4.65	4.45
34-35	25.05	31.68	32.66	84-85		4.39	4.22
35-36	24.51	31.00	31.90	85-86		4.12	4.00
36-37	23.97	30.32	31.16	86-87		3.90	3.79
37-38	23.43	29.63	30.42	87-88		3.71	3.58
38-39	22.88	28.95	29.68	88-89		3.59	3.39
39-40	22.33	28.27	28.94	89-90		3.47	3.20
40-41	21.78	27.61	28.20	90-91		3.28	3.03
41-42	21.23	26.97	27.46	91-92		3.26	2.87
42-43	20.73	26.33	26.73	92-93		3.37	2.73
43-44	20.23	25.71	25.99	93-94		3.48	2.59
44-45	19.72	25.08	25.26	94-95		3.53	2.47
45-46	19.22	24.45	24.54	95-96		3.53	2.35
46-47	18.72	23.81	23.82	96-97		3.46	2.24
47-48	18.21	23.16	23.10	97-98		3.28	2.14
48-49	17.71	22.50	22.39	98-99		3.07	2.04
49-50	17.25	21.81	21.69	99-100		2.77	1.95

Figure 2 gives the results from Halley's table, based upon the mortality experience in the City of Breslau, in Silesia, during the years 1687 to 1691. This gives us a picture of the forces of mortality towards

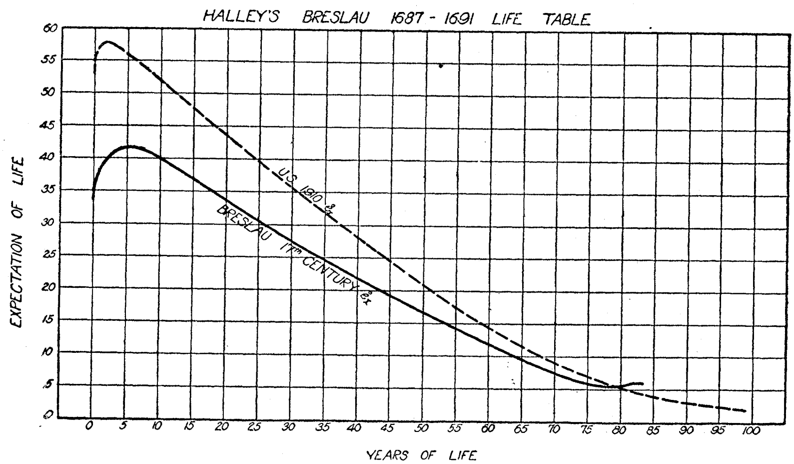

FIG. 2. COMPARING THE EXPECTATION OF LIFE IN THE 17TH CENTURY WITH THAT OF THE PRESENT TIME

the end of the seventeenth century. From this diagram it appears that at birth the expectation of life of an individual born in Breslau in the seventeenth century was very much lower than that of an individual born in the United States in 1910. The difference amounts to approximately 18 years! At 10 years of age, however, this difference in expectation of life had been reduced to just over 12 years; at age 20, to a little less than 10 years; at age 30 to 7-1/3 years; at age 50 to just over 4 years; at age 70 to 1-1/2 years. At age 80 the lines have crossed. The individual 80 years old in Breslau could expect to live on the average a half year *longer* than the individual of the same age in the United States in 1910. At age 83, the last year covered by Halley's table, the 17th century individual could expect on the average to live approximately a year and a half longer than his twentieth century brother. So then what the diagram shows is that the expectation of life at early ages was vastly inferior in the seventeenth century to what it is now, while at advanced ages the chances of living were distinctly better—*relatively* enormously better—then than they are now. Let us defer the further discussion of the meaning and explanation of this curious fact until we have examined some further data.

Figure 3 compares the expectation of life in England at the middle of the eighteenth century, or about a century later than the last, with present conditions in the United States. Again we see that the expectation at birth was greatly inferior then to what it is now, but the difference is not so great as it was a century earlier, amounting to but 12-3/4 years instead of the 18 we found before. Further it is seen that, just as before, the expectations come closer together with advancing age. By the time age 45—middle life—is reached the expectation of life was substantially the same in the eighteenth century as it is now. At age 47 the eighteenth century line crosses that for the twentieth century,

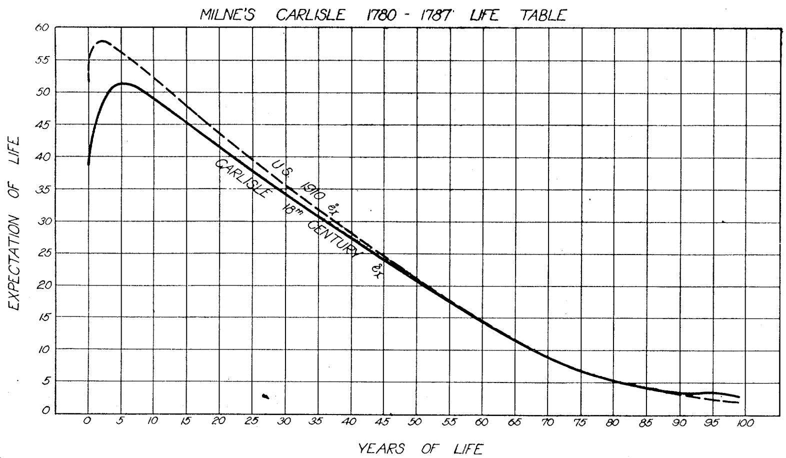

FIG. 3. COMPARING THE EXPECTATION OF LIFE IN THE 18TH CENTURY WITH THAT OF THE PRESENT TIME

and with a few trifling exceptions, notably in the years from 56 to 62, the expectation of life for all higher ages was greater then than it is now. Or we see in the eighteenth century the same *kind* of result as in the seventeenth, only differing in degree.

The changes in expectation of life from the middle of the seventeenth century to the present time furnish a record of a real evolutionary progression. In this respect at least man has definitely and distinctively changed, as a race, in a period of three and a half centuries. This is, of course, a matter of extraordinary interest, and at once stimulates the desire to go still farther back in history and see what the expectation of life then was. Fortunately, through the labors of Karl Pearson, and his associate, W. R. Macdonell, it is possible to do this, to at least a first approximation. Pearson has analyzed the records as to age at death which were found upon mummy cases studied by Professor W. Spiegelberg. These mummies belonged to a period between 1900 and 2000 years ago, when Egypt was under Roman dominion. The data were extremely meager, but from Pearson's analysis of them it has been possible to construct the diagram which is shown in Figure 4. Each circle marks a point where it was possible definitely to calculate an expectation of life. The curve running through the circles is a rough graphic smoothing of the scattered observed data. Unfortunately, there were no records of deaths in early infancy. Either there were no baby mummies, or if there were they have disappeared. For comparison, the expectation of life from Glover's 1910 United States life table is inserted.

It will be seen at once that the general sweep of the line is of the same sort that we have already observed in the case of the seventeenth century table. In the early years of life the expectation was far below that of the present time, but somewhere between ages 65 and 70 the

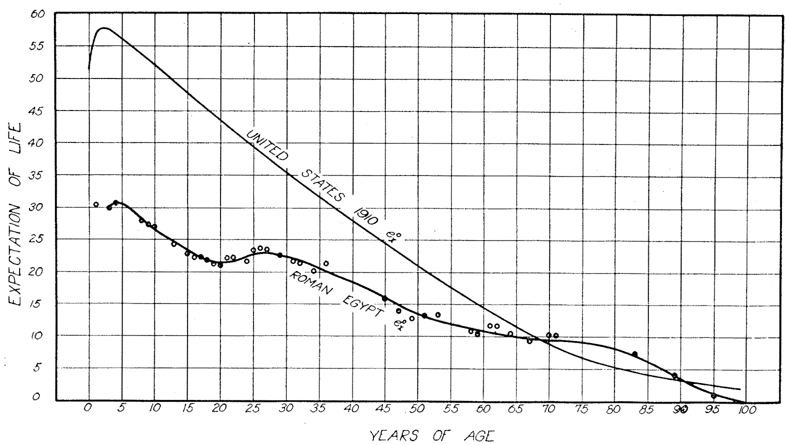

FIG. 4. COMPARING THE EXPECTATION OF LIFE OF ANCIENT EGYPTIANS WITH THAT OF PRESENT DAY AMERICANS. Plotted from Pearson's and Glover's data

Egyptian line crosses the modern American line, and from that period on the individuals living in Egypt at about the time of the birth of Christ could look forward to a longer remaining duration of life, on the average, than can the American of the present day. Pearson's comment on this fact is worth quoting. He says: "In the course of those centuries man must have grown remarkably fitter to his environment, or else he must have fitted his environment immeasurably better to himself. No civilized community of to-day could show such a curve as the civilized Romano-Egyptians of 2,000 years ago exhibit. We have here either a strong argument for the survival of the physically fitter man or for the survival of the civilly fitter society. Either man is constitutionally fitter to survive to-day, or he is mentally fitter, i. e., better able to organize his civic surroundings. Both conclusions point perfectly definitely to an evolutionary progress. . . . That the expectation of life for a Romano-Egyptian over 68 was greater than for a modern English man or woman is what we might expect, for with the mortality of youth and of middle age enormously emphasized only the very strongest would survive to this age. Out of 100 English alive at 10 years of age 39 survive to be 68; out of 100 Romano-Egyptians not 9 survived. Looking at these two curves we realize at a glance either the great physical progress of man, which enables him far more effectually to withstand a hostile environment, or the great social and sanitary progress he has made which enables him to modify the environment. In either case we can definitely assert that 2,000 years has made him a much 'fitter' being. In this comparison it must be remembered that we are not placing a civilized race against a barbaric tribe, but comparing a modern civilization with one of the highest types of ancient civilization."

Macdonell was able to continue this investigation, on much more

extensive material extracted from the *Corpus Inscriptionum Latinarum* of the Berlin Academy, which gives records as to age of death for many thousand Roman citizens dying, for the most part, within the first three or four centuries of the Christian era. His material may, therefore, be taken to represent the conditions a few centuries later than those of Pearson's Romano-Egyptian population. Macdonell was able to calculate three tables of expectation of life—the first for Roman citizens living in the city of Rome itself; second, for those living in the provinces of Hispania and Lusitania; and third, for those living in Africa. The results are plotted against the United States 1910 data, as before, in Figures 5, 6 and 7.

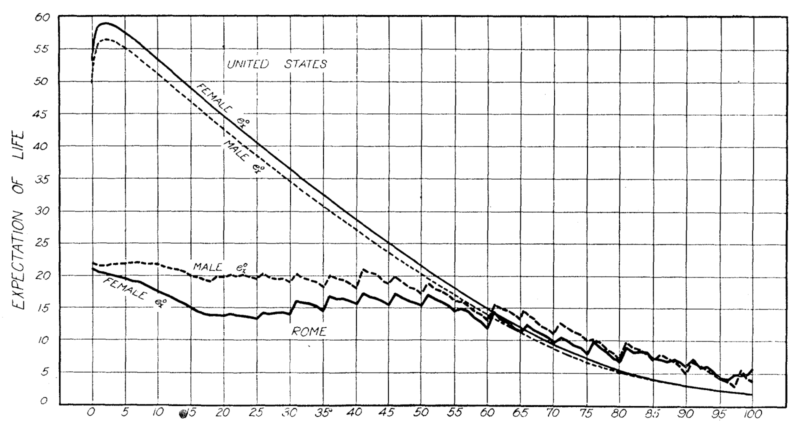

FIG. 5. COMPARING THE EXPECTATION OF LIFE OF ANCIENT ROMANS WITH THAT OF PRESENT DAY AMERICANS. Plotted from Macdonell's and Glover's data

Figure 5 relates to inhabitants of the city of Rome itself. The populations from which the expectations are calculated run into the thousands, and fortunately one is able to separate males and females. As in Pearson's case, which we have just examined, modern American data are entered for comparison. It will be noted at once that just as in the Romano-Egyptian population the expectation of life of inhabitants of ancient Rome was, in the early years of life, immensely inferior to that of the modern population. From about age 60 on, however, the expectation of life was better then than now. Curiously enough, the expectation of life of females was poorer at practically all ages of life than that of the males, which exactly reverses the modern state of affairs. Macdonell believes this difference to be real, and to indicate that there were special influences adversely affecting the health of females in the Roman Empire, which no longer operate in the modern world. Up to something like age 25 the expectation of life of dwellers in the city of Rome was extremely bad, worse than in the Romano-Egyptian population which Pearson studied, or in the popu-

lations of other parts of the Roman Empire as we shall see in the following diagram. Macdonell thinks that this difference is real and due to circumstances peculiar to Rome.

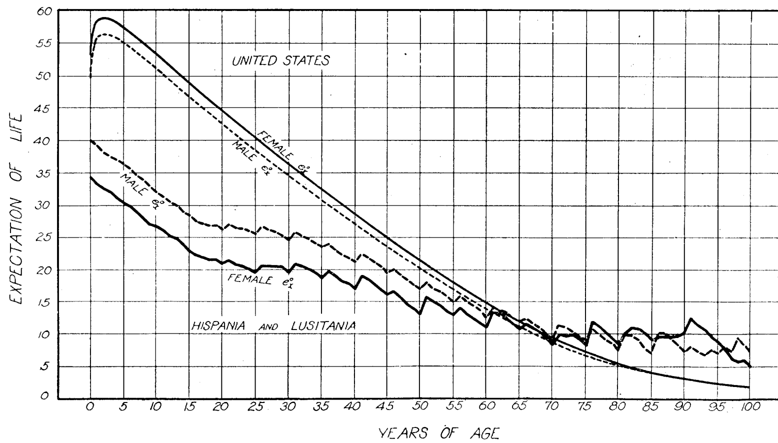

FIG. 6. COMPARING THE EXPECTATION OF LIFE OF THE POPULATION OF THE ROMAN PROVINCES HISPANIA AND LUSITANIA WITH THAT OF PRESENT DAY AMERICANS. Plotted from Macdonell's and Glover's data

The general features of the diagram for the population of Hispania and Lusitania (Figure 6) are similar to those that we have seen, with the difference that the expectation of life up to age 20 or 25 is not as bad as in the city of Rome itself. Again the females show a lower expectation practically throughout life than do the males. The lines cross the modern American lines at about age 60 and from that point on these colonial Romans had a better expectation of life than the modern American has.

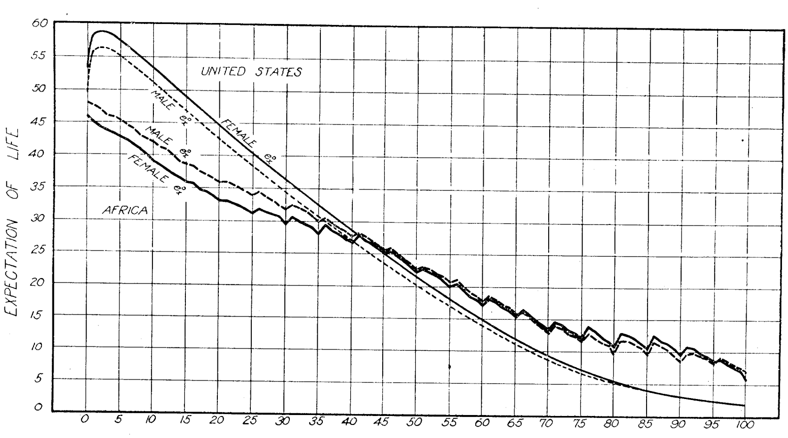

FIG. 7. COMPARING THE EXPECTATION OF LIFE OF THE POPULATION OF THE ROMAN PROVINCES IN AFRICA WITH THAT OF PRESENT DAY AMERICANS. Plotted from Macdonell's and Glover's data

The Romano-African population diagram appears to start at nearly the same point at birth as does the modern American and in general the differences up to age 35 are not substantially more marked from modern conditions than they are in the seventeenth century Breslau table. The striking thing, however, is that at about age 40 the lines cross, and from then on the expectation of life was definitely superior in the early years of the Christian era to what it is now.

It should be said that the curious zigzagging of the lines in all of these Roman tables of Macdonell is due to the tendency, which ancient Romans apparently had in common with present day American negroes, towards heavy grouping on the even multiples of 5 in the statement of their ages.

Summarizing the whole matter we see that during a period of approximately 2,000 years man's expectation of life at birth and subsequent early ages has been steadily improving, while at the same time his expectation of life at advanced ages has been steadily worsening. The former phenomenon may be attributed essentially to ever increasing knowledge of how best to cope with the lethal forces of nature. Progressively better sanitation, in the broadest sense, down through the centuries has saved for a time the lives of ever more and more babies and young people who formerly could not withstand the unfavorable conditions they met, and died in consequence rather promptly. But just because this process tends to preserve the weaklings, who were speedily eliminated under the rigorous action of unmitigated natural selection, there appear now in the higher age groups of the population many weaker individuals than formerly ever got there. Consequently the average expectation of life at ages beyond say 60 to 70 is not nearly so good now as it was under the more rigorous régime of ancient Rome. Then any individual who attained age 70 was the surviving resultant of a bitterly destructive process of selection. To run successfully the gauntlet of early and middle life he necessarily had to have an extraordinarily vigorous and resistant constitution. Having come through successfully to 70 years of age it is no matter of wonder that his prospects were for a longer old age than his descendants of the same age to-day can look forward to. Biologically these expectation of life curves give us the first introduction to a principle which we shall find as we go on to be of the very foremost importance in fixing the span of human longevity, namely that *inherited constitution fundamentally and primarily determines how long an individual will live.*

3. Analysis of the Life Table

I shall not develop this point further now, but instead will turn back to consider briefly certain features of the d_x line of a life table. Figure 1 shows that this line, which gives the number of deaths occur-

ring at each age, has the form of a very much stretched letter S resting on its back. Some years ago Pearson undertook the analysis of this complex curve, and drew certain interesting conclusions as to the fundamental biological causes lying behind its curious sinuosity. His results are shown in Figure 8.

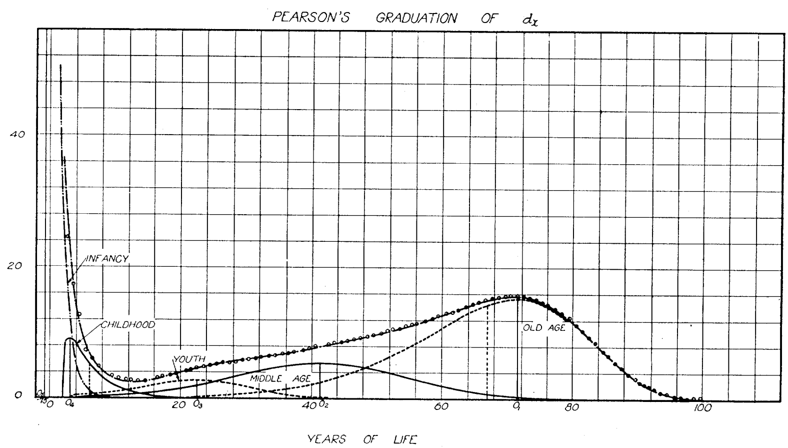

FIG. 8. SHOWING PEARSON'S RESULTS IN FITTING THE *Dx* LINE OF THE LIFE TABLE WITH 5 SKEW FREQUENCY CURVES. Plotted from the data of Pearson's original memoir on "Skew Variation" in the Phil. Trans. Roy. Soc.

He regarded the d_x line of the life table as a compound curve, and by suitable mathematical analysis broke it up into five component frequency curves. The data which he used were furnished by the d_x line of Ogle's life table, based on the experience of 1871 to 1880 in England. This line gives the deaths per annum of one thousand persons born in the same year. The first component which he separated was the old age mortality. This is shown by the dotted curve having its modal point between 70 and 75 years, at the point lettered O_1 on the base of the diagram. This component, according to Pearson's graduation, accounted for 484.1 deaths out of the total of 1,000, or nearly one-half of the whole. Its range extends from under 20 years of age to the upper limit of life, at approximately 106 years. The second component includes the deaths of middle life. This is the smooth curve having its modal point between 40 and 45 years at the point on the base marked O_2. Its range extends from about 5 years of age to about 65. It accounts for 175.2 deaths out of the total of 1,000. It is a long, much spread out curve, exhibiting great variability. The third component is made up by the deaths of youth. This accounts for 50.8 deaths out of the total of a thousand, and its range extends from about the time of birth to nearly 45 years. Its mid-point is between 20 and 25 years, and it exhibits less variability than either the middle life or the old age curves. The fourth component, the modal point of which is at the point on the base of the diagram marked O_4 covers the childhood

mortality. It accounts for 46.4 deaths out of the total of 1,000. Its range and variability are obviously less than those of any of the other three components so far considered. The last, excessively skew component, is that which describes the mortality of infancy. It is given by a J shaped curve accounting for 245.7 deaths after birth, and an antenatal mortaliy of 605. In order to get any fit at all for this portion of the mortality curve it is necessary to assume that the deaths *in utero* and those of the first months after birth are a homogeneous connected group.

Summing all these components together it is seen that the resulting smooth curve very closely fits the series of small circles which are the original observations. From the standpoint merely of curve fitting no better result than this could be hoped for. But about its biological significance the case is not quite so clear, as we shall presently see.

Pearson himself thinks of these five components of the mortality curve as typifying five Deaths, shooting with different weapons, at different speeds and with differing precision at the procession of human beings crossing the Bridge of Life. The first Death is, according to Pearson, a marksman of deadly aim, concentrated fire, and unremitting destructiveness. He kills before birth as well as after and may be conceived as beating down young lives with the bones of their ancestors. The second marksman who aims at childhood has an extremely concentrated fire, which may be typified by the machine gun. Only because of the concentration of this fire are we able to pass through it without appalling loss. The third marksman Death, who shoots at youth has not a very deadly or accurate weapon, perhaps a bow and arrow. The fire of the fourth marksman is slow, scattered and not very destructive, such as might result from an old fashioned blunderbus. The last Death plies a rifle. None escapes his shots. He aims at old age but sometimes hits youth. His unremitting activity makes his toll large.

We may let Pearson sum the whole matter up in his own words: "Our investigations on the mortality statistics have thus led us to some very definite conclusions with regard to the chances of death. Instead of seven we have five ages of man, corresponding to the periods of infancy, of childhood, of youth, of maturity or middle age, and of senility or old age. In the case of each of these periods we see a perfectly regular chance distribution, centering at a given age, and tailing off on either side according to a perfectly clear mathematical law. . .

"Artistically, we no longer think of Death as striking chaotically; we regard his aim as perfectly regular in the mass, if unpredictable in the individual instance. It is no longer the Dance of Death which pictures for us Death carrying off indiscriminately the old and young, the rich and the poor, the toiler and the idler, the babe and its grandsire. We see something quite different, the cohort of a thousand tiny mites

starting across the Bridge of Life, and growing in stature as they advance, till at the far end of the bridge we see only the gray-beard, and the 'lean and slippered pantaloon.' As they pass along the causeway the throng is more and more thinned; five Deaths are posted at different stages of the route longside the bridge, and with different skewness of aim and different weapons of precision they fire at the human target, till none remains to reach the end of the causeway—the limit of life."

This whole, somewhat fanciful, conception of Pearson's needs a little critical examination. What actually he has done is to get a good empirical fit of the d_x line by the use of equations involving all told some 17 constants. Because the combined curve fits well, *and fundamentally for no other reason,* he implicitly concludes that the fact that the fit is got by the use of five components means biologically that the d_x line is a compound curve, and indicates a five-fold biological heterogeneity in the material. But it is a very hazardous proceeding to draw biological conclusions of this type from the mere fact that a theoretical mathematical function or functions fits well a series of observational data. I have fully discussed this point several years ago (Pearl: Amer. Nat. Vol. XLIII) where I pointed out:

"The kind of evidence under discussion can at best have but inferential significance; it can never be of demonstrative worth. It is based on a process of reasoning which assumes a fundamental or necessary relationship to exist between two sets of phenomena because the same curve describes the quantitative relations of both sets. A little consideration indicates that this method of reasoning certainly can not be of general application, even though we assume it to be correct in particular cases. The difficulty arises from the fact that the mathematical functions commonly used with adequate results in physical, chemical, biological, and mathematical investigations are comparatively few in number. The literature of science shows nothing clearer than that the same type of curve frequently serves to describe with complete accuracy the quantitative relations of widely different natural phenomena. As a consequence any proposition to include that two sets of phenomena are casually or in any other way fundamentally related solely because they are described by the same type of curve is of a very doubtful validity."

Henderson has put Pearson's five components together in a single equation, and says regarding this method of analyzing the life tables: " . . . it is difficult to lay a firm foundation for it, because *no analysis of the deaths into natural divisions by causes or otherwise has yet been made* such that the totals in the various groups would conform to those frequency curves." The italics in this quotation are the present writer's for the purpose of emphasizing crucial points of the whole matter, which we shall immediately discuss in more detail.

Now it is altogether probable that one could get just as good a fit to the observed d_x line as is obtained by Pearson's five components by using a 17 constant equation of the type

$$y=a+bx+cx^2+dx^3+ex^4+fx^5+gx^6+\text{- - - - - - - -}+nx^{16}$$

and in that event one would be quite as fully justified (or really unjustified) in concluding that the d_x line was a homogeneous curve as Pearson is in concluding from his five-component fit that it is compound.

Indeed Wittstein's formula involving but four constants gives substantially good fit over the whole range of life.

But in neither case is the curve-fitting evidence, by and of itself, in any sense a demonstration of the biological homogeneity or heterogeneity of the material. Of far greater importance, and indeed conclusive significance, is the fact, to be brought out in a later paper in this series, that in material *experimentally known to be biologically homogeneous,* a population made up of full brothers and sisters out of a brother x sister mating and kept throughout life in a uniform environment identical for all individuals,*one gets a d_x line in all its essential features,* save for the absence of excessive infant mortality arising from perfectly clear biological causes, *identical with the human d_x line.* It has long been apparent to the thoughtful biologist that there was not the slightest biological reason to suppose that the peculiar sinuosity of the human d_x line owed its origin to any fundamental heterogeneity in the material, or differentiation in respect of the forces of mortality. Now we have experimental proof, to be discussed in a later paper in this series, that with complete homogeneity of the material, both genetic and environmental, one gets just the same kind of d_x line as in normal human material. We must then, I think, come to the conclusion that brilliant and picturesque as is Pearson's conception of the five Deaths, actually there is no slightest reason to suppose that it represents any *biological* reality, save in the one respect that his curve fitting demonstrates, as any other equally successful would, that deaths do not occur chaotically in respect of age, but instead in a regular manner capable of representation by a mathematical function of age.